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FEDERAL COMMUNICATIONS COMMISSION
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Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Replacement of Part 90 by Part 88 to Revise the Private Land Mobile Radio Services and Modify the Existing Policies Governing Them	)	PR Docket No. 92-235

To: The Commission

REPLY COMMENTS OF ADVANCED MOBILECOMM, INC.

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SUMMARY

In its initial Comments in this proceeding, AMI expressed strong concern that the Commission appeared to be showing some hesitancy in ordering 5 kHz channelization rather than the less efficient 6.25 kHz channelization. Responding to that hesitancy, AMI argued strenuously that it believed ". . . that the arguments specifically in favor of 6.25 kHz rather than 5 kHz are without merit when the larger overall context of soectrum efficiency is consodered and when the current and future state-of-the-art is taken into consideration." AMI's arguments in favor of the narrower channel spacing were based upon (a) its experience as a provider of land mobile radio services and (b) an extensive engineering analysis of the advantages and disadvantages of both approaches.

In the interim since the initial round of filings, AMI has carefully reviewed and analyzed the comments submitted by other parties, and for the reasons expressed herein, has concluded that arguments in favor of 6.25 kHz channelization are either without merit or are unpersuasive when compared to the benefits of the 5 kHz alternative. For these reasons, AMI continues to respectfully urge the Commission to adopt 5 khz channelization as a conservative compromise in terms of today's technology, future user requirements, and the need to carefully husband the nation's precious spectrum resource.

Before the
FEDERAL COMMUNICATIONS COMMISSION

proceeding, the Commission appeared to be showing some hesitancy in ordering more efficient 5 kHz channelization. AMI responded to this seeming hesitation by stating that it believed ". . .that the arguments specifically in favor of 6.25 kHz rather than 5 kHz are without merit when the larger, overall context of spectrum efficiency is considered and when the current and future state-of-the-art is taken into consideration."

In the interim, AMI has carefully reviewed the initial

increase in trunking efficiency associated with larger trunk groups.

Third, 5 kHz is a common, even divisor of both 25 kHz and 30 kHz, the basic channel sizes currently employed in the major bands at issue.

Fourth, the smaller bandwidth of the 5 kHz channel means that smaller increments of bandwidth can be combined on either a "realtime" or longer term basis to provide a closer match of total bandwidth to the needed information bandwidth.[2]

In short, AMI believes that 5 kHz channelization is, in reality,

to--or exceeding--rates achieved with today's equipment, (b) channels can be stacked to provide the atypical needs when justified, and (c) there is relatively little difference in data capacity between 5 and 6.25 kHz in any event and, in either case, stacking would be required for greater capacity in an approximately equal fraction of the cases.

Second, the Commission itself has indicated that 6.25 kHz channelization might be preferred because it would permit the creation of additional offset channels. AMI remains somewhat confused as to the basis for this claim, but AMI maintains that (a) in the long term, these low power offset channel operations should be migrated to the new 2 GHz Personal Communication Services (PCS) band where both licensed and unlicensed, low power, limited range services are being contemplated by the Commission and (b) in any case, the public interest would be better served if the bands to be refarmed were re-channelized into 5 kHz channels and existing users of offset channels were accommodated on a normal, non-offset basis on the new channels so as to minimize interference produced and received.

Third, some proponents of wider channelization have argued that the 5 kHz technology is "unproven." However, as pointed out in AMI's initial comments, this argument is belayed by the very presence of five manufacturers of 5 kHz equipment and the apparent absence of manufacturers of 6.25 kHz equipment at the Commission's recent Refarming Technical Roundtable.

In the initial comment round, some proponents (primarily Motorola) have tried to bolster this argument against either 5 or 6.25 kHz channelization on the basis that 5 kHz systems have been unsuccessful in the 150-174 MHz band. But these arguments are without merit because the limited success of 5 kHz systems in the 150 MHz band has essentially nothing to do with the technology itself.

As SEA points out in its comments in this proceeding, the Commission action in introducing narrowband in the 150 MHz band was limited to the simple application of new rules to merely permit the use of the more efficient technology. They also note, quite correctly in AMI's opinion, that the original initiative was flawed because of (a) the lack of multi-channel opportunities, (b) the problems associated with sharing in a band with no channel exclusivity, and (c) the fact that the Commission made available a significant number of new channels in other regions of the spectrum that removed the sense of urgency from the need to implement narrowband technologies in the 150 MHz band.

Based upon AMI's own knowledge of the situation, a major problem was the interference situation which tended to be exacerbated by over-deviation and off-channel operation of incumbent FM systems. Another major limitation was the lack of trunking systems which reduced the desirability of the 150 MHz narrowband systems, especially compared to the trunked systems in operation in the 800 MHz band.

Moreover, the narrowband, 5 kHz equipment was regarded as too expensive by many users but this simply reflected (a) a "chicken and egg" problem in terms of cost versus volume and (b) the fact that the equipment suppliers were small firms that had to purchase parts in small quantities and were limited in their ability to absorb "upfront" developmental costs. There will not be a significant "chicken and egg" problem if the Commission acts decisively to require the introduction of the more spectrally efficient narrowband technology in the bands at issue in this proceeding. Furthermore, more recently, Digital Signal Processing (DSP) "chips" have become a great equalizer in the cost structure of equipments having considerably different architectures and this has softened the cost versus volume relationship as well.

To reiterate, the factors that limited the success of 5 kHz systems in the 150 MHz band were not of a fundamental technical nature at all. Stated another way, what customer would choose service on shared (non-exclusive), interference-prone, non-trunked systems when service without these problems was available in the 800 MHz band? These non-technical factors (e.g., lack of an adequate number of exclusive channels for effective trunking) will not pertain to refarming if the Commission adopts rules and regulatory processes advocated by AMI in this and the earlier proceeding. In short, the arguments that 5 kHz systems are unproven are simply without merit.

B. Other Arguments Raised in the Comments

Some commenters have alleged that very narrowband systems (i.e., both 5 kHz and 6.25 kHz) would have more technical problems than today's "normal" bandwidth systems with respect to several system parameters.[3] These claims, which involve the impact of intermodulation, fading, multipath, and impulse noise are addressed in the paragraphs which follow:

Some commenters have noted that the number of intermodulation (IM) products per 1 MHz of bandwidth goes up exponentially with the ratio of the channel bandwidths being considered. AMI readily admits that this statement is quite incontrovertible but, even given its truth, it does not mean that it is of any practical consequence. Intermodulation performance is primarily a design factor and, if normal, good engineering practices are followed, it can be handled appropriately. In fact, the land mobile radio community, to its credit, has successfully made the transition to narrower channels many times in the past and there is no reason to suspect that intermodulation performance will be any more of a limiting factor than it has been in the past.

More specifically, AMI notes that it is potentially misleading to compare the number of IM products produced on a per Megahertz basis as done by one commenter.[4] Instead, a more

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[3] For example, see the comments of Ericsson GE Mobile Communications, Inc., pp. ii and 10-11; TIA, pp. 12-13; and APCO, pp. 27-29.

[4] See comments of the TIA, pp. 12-13.

meaningful measure is the number of IM products that fall within the channel bandwidths. This, of course, reduces the number of IM products down by roughly a factor of five for 5 kHz versus 25 kHz channels relative to the numbers of products occurring in 1 MHz of spectrum.

Moreover, as opposed to traditional FM radio systems, where non-linear transmitter and receiver operation is the norm, very narrowband systems typically employ Linear Modulation Techniques (LMT). In systems employing such techniques, both transmitters and receivers must maintain extreme linearity. This means that, for given levels of interfering signals entering the transmitter output stages or into receivers, the generation of IM products should be considerably less than with today's "normal" FM systems.

Thus, even though the numbers of IM products generated

transmission. However, the widespread adoption of powerful, cost-effective DSP devices has solved this problem with linear systems. Thus, equalization or linearization of very narrowband channels is no longer a significant problem.

On the other hand, "normal" bandwidth mobile systems are increasingly being designed for high-level modulation that requires a higher degree of linearity in the channel as well. Thus, any such problems are not solely the domain of very narrowband equipments and systems.

Some commenters have also claimed that multipath fading is more difficult to deal with in very narrowband systems. It is certainly true that very wideband systems (e.g., spread spectrum systems) can obtain some of the anti-fading advantages of frequency diversity. But in order to achieve this advantage, the system bandwidth must exceed the correlation bandwidth of the channel so that differing signal frequencies tend to fade independently. However, the correlation bandwidth of typical mobile channels tends to exceed the bandwidth of today's "normal" bandwidth systems, thus any possible frequency diversity improvements are minimal for both "normal" and very narrowband systems.

In fact, the very narrowband systems can tend to have an advantage over "normal" bandwidth systems in a fading environment when, for example, high digital signaling rates are involved. That is, intersymbol interference tends to be less of a problem with very narrowband systems whereas, with higher

signaling rates in 25 or 30 kHz channels, such intersymbol interference can be a serious concern. For example, the TDMA-based digital cellular system now being implemented in the U.S. utilizes a 48.6 kbps signaling rate (24.3 kilosymbols per second) and requires a channel equalizer to combat the effects of the delay spread produced by severe multipath.[5]

Finally, one commenter claimed that very narrowband systems have more problems combating the effects of impulse (e.g., ignition) noise than wider bandwidth systems.[6] Interestingly, one commenter claimed that very narrowband systems are less sensitive to the effects of impulse noise.[7] This argument is based upon the observation that impulse noise tends to have a much wider spectral bandwidth than the bandwidth of both "normal" and very narrowband systems. Thus, as far as the average noise power entering the receiver is concerned, the very narrowband systems will admit less noise power than their wider bandwidth counterparts. On the basis of average power, then, very narrowband systems have a significant advantage over wider bandwidth systems.

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[5] It is interesting to note that the proponents of digital narrowband FDMA cellular systems made the lack of the need for channel equalization a big factor in their arguments in favor of digital narrowband FDMA systems over wider bandwidth TDMA systems.

[6] See the comments of Ericsson GE Mobile Communications, Inc., pp. ii and 10-11.

[7] See comments of Securicor PMR Systems Ltd., p. 6.

In fairness, however, some very narrowband systems may be more susceptible to pulse stretching from impulse noise even though the average noise power entering the receiver is less. The increased susceptibility to the effects of pulse stretching stems from the fact that the pulse stretching produced by noise pulses will be greater in a very narrowband system. However, there are a variety of methods to combat impulse noise before it is filtered in very narrowband ("high-Q") filters in the receiver. These methods include noise clipping, blanking, and cancelling. By employing these (or combination of these) techniques in the wider bandwidth portion of the receiver where the pulse stretching effects are less pronounced, the resulting signal can be passed through subsequent very narrowband filters with greatly reduced impact.

Thus, when good design practices are followed, very narrowband systems need not be more susceptible to impulse noise than wider bandwidth systems and, where average noise power entering into a receiver is the primary concern, they have a distinct advantage. In any event, as far as the choice between 5 kHz and 6.25 kHz channelization is concerned, the difference between the two in terms of these effects would be essentially negligible.

IV. CONCLUSION

In its initial comments in this proceeding, AMI argued strenuously that the benefits favoring 5 kHz channelization far exceeded those favoring 6.25 kHz channelization. Those arguments

were based upon (a) AMI's experience as an provider of land mobile radio services and (b) an extensive engineering analysis of the advantages and disadvantages of both approaches. In the interim, AMI has carefully reviewed the initial comments filed by other parties, and for the reasons expressed herein, has concluded that the arguments in favor of 6.25 kHz channelization are either without merit or are unpersuasive when compared with the 5 kHz alternative. For these reasons, AMI continues to urge the Commission to adopt 5 kHz channelization as a conservative compromise in terms of today's technology, future user requirements, and the need to carefully husband the nation's precious spectrum resource.

Respectfully submitted,

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By: Harold C. Davis/RR

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July 30, 1993

CERTIFICATE OF SERVICE

I, Dottie E. Holman, hereby certify that copies of the foregoing Reply Comments Advanced MobileComm, Inc., were mailed, postage prepaid, this 30th day of July, 1993, to the following parties:

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